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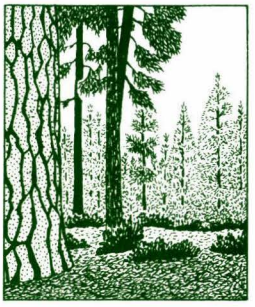

FOREST RESEARCH NOTES

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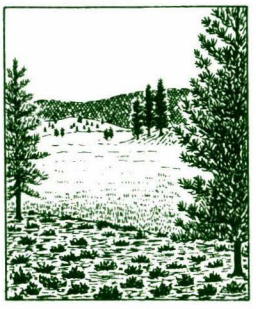

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GERMINATION OF THIOUREA-TREATED BITTERBRUSH SEED IN THE FIELD[1/]

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Bitterbrush (Purshia tridentata) is one of the most important forage plants for big game and livestock in the West. In many areas this browse plant has deteriorated or been killed out by livestock, deer, insects, and other causes. Studies are now underway in several western states to find ways of reseeding bitterbrush artificially.

One hindrance to reseeding is dormancy of bitterbrush seed. Dormancy can be broken by over-wintering in the soil[3/], artificial stratification[4/], or soaking in a solution of thiourea[5/]. Fall planting provides the over-wintering which naturally breaks the seed dormancy but spring planting is often desirable. Stratified seed, however, is too soft and moist for spring planting with mechanical equipment. Thiourea treatment is satisfactory; it leaves seed dry and entirely suitable for mechanical equipment. Laboratory tests[5/] had indicated that 4 minutes soaking in a 3 percent thiourea solution or 30 minutes in a 1 percent solution gave best germination results, but the best treatment for field plantings, where moisture and temperature are less favorable, was not known. This note reports the results of a field trial in two areas.

1/ Contribution from cooperative investigation between the California Forest and Range Experiment Station and the California Department of Fish and Game. Work was done under Federal Aid in Wildlife Restoration Act, Pittman-Robertson Research Project W51R, entitled "Game Range Restoration."

2/ Formerly with this Station, now on the Wallowa-Whitman National Forest, Wallowa, Oregon.

3/ Hormay, August L. 1943. Bitterbrush in California. Calif. Forest and Range Expt. Sta. Res. Note 34.

4/ Mirov, N. T. and Kraebel, Charles J. 1939. Civilian Conservation Corps. Forestry Pub. No. 5.

5/ Pearson, Bennett O. 1957. Bitterbrush seed dormancy broken with thiourea. Jour. Range Mgmt. 10:41-42.

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DESCRIPTION OF PLANTING AREAS

Thiourea-treated seed was planted at two locations in northeastern California. The northernmost was the Flukey Spring Experimental Area in Modoc County, on the winter range of the California-Oregon interstate deer herd. Here the vegetation is a transition phase between the ponderosa pine and sagebrush-juniper types. Big sagebrush (Artemisia tridentata), juniper (Juniperus occidentalis), rabbitbrush (Chrysothamnus spp.), and bitterbrush are the principal shrubs. The understory is composed of perennial grasses and annual and perennial forbs. A few scattered ponderosa pine (Pinus ponderosa) are present. Annual precipitation averages between 12 and 14 inches, much of it falling as snow from November to March. The soil is a sandy loam of basalt origin.

The other area was located near Doyle, California, about 45 miles north of Reno, Nevada, on the winter range of the Lassen-Washoe deer herd. Here the principal shrubs are big sagebrush, rabbitbrush, and bitterbrush. The understory is composed mainly of cheatgrass (Bromus tectorum), perennial grasses, and annual and perennial forbs. Precipitation averages about 9.5 inches annually. The soil is a coarse sandy loam of granitic origin.

SEED TREATMENTS AND PLANTING DESIGN

Eight thiourea treatments, some above and some below the laboratory "optimum" soaking time reported by Pearson, were used:

Percent thiourea solution	Soaking time in solution (minutes)
3	1/2
3	2
3	3
3	4
3	8
1	5
1	30
1	75

Seed stratified at 41°F. for 8 weeks were used as checks.

Seed from each treatment were planted at random in each of 5 blocks as a single row of 10 seed spots spaced 1 foot apart. Each spot held 5 seeds, 1 in each corner of a 1-1/2 inch sqare and 1 in the center. Planting was at 1-inch depth at both locations.

The planting areas were plowed, weeded, and fenced from deer and livestock. Seed spots were protected from rodents during the first spring by hardware-cloth domes.

RESULTS AND DISCUSSION

At Flukey Spring 8 minutes in 3 percent thiourea and 75 minutes in 1 percent gave the highest seedling emergence (table 1). One-half to 3 minutes in 3 percent solution and 5 minutes in 1 percent were very low, and the other treatments were intermediate. Even the best results with thiourea treatment were only two-thirds as good as seedling emergence from stratified seed.

Table 1.--Seedling emergence from thiourea-treated and stratified bitterbrush seed

Treatment	Flukey Spring		Doyle Area	
	Total 1/ emergence	Percent emergence	Total 1/ emergence	Percent emergence
	No.		No.	
3%, 30 sec.	14	5.6	39	15.6
3%, 2 min.	19	7.6	88	35.2
3%, 3 min.	27	10.8	101	40.4
3%, 4 min.	34	13.6	98	39.2
3%, 8 min.	111	44.4	77	30.8
1%, 5 min.	15	6.0	40	16.0
1%, 30 min.	54	21.6	132	52.8
1%, 75 min.	111	44.4	79	31.6
Stratified check	167	66.8	39	15.6

1/ Total seedlings emerged in 5 replications of 50 seed each.

In the Doyle test, 30 minutes soaking in 1 percent thiourea gave the highest emergence. One-half minute in 3 percent, 5 minutes in 1 percent, and stratification all were very low. Other treatments gave 30 to 40 percent emergence. The best thiourea treatment at Doyle was considerably better than any of the thiourea treatments at Flukey Spring.

Rate as well as total amount of seedling emergence was influenced by the thiourea treatments compared to stratification. At Flukey Spring the total number of seedlings produced by the stratified seed had emerged by May 3 (table 2). Three thiourea treatments had 85 to 86.5 percent of their seedlings above ground by this date; 3 lagged badly with only 7 to 21 percent of the seedlings emerged by May 3; and 2 were 44 and 62 percent complete. The differences indicate that weak thiourea treatments failed to break seed dormancy. The differences also point to a definite trend toward better success with stronger treatments. This trend was not so well established at Doyle where less frequent observations were made.

Table 2.--Rate of seedling emergence from thiourea-treated and stratified bitterbrush seed, Flukey Spring

Treatment	April 26	May 3	May 15	May 31	June 27	Oct 9	Total emergence	Percentage of total emergence occurring by May 3
	--No. seedlings emerged since previous exam.--							
3%, 30 sec.	0	1	0	10	3	0	14	7.1
3%, 2 min.	4	0	2	11	2	0	19	21.0
3%, 3 min.	11	1	5	9	1	0	27	44.4
3%, 4 min.	18	3	1	12	0	0	34	61.8
3%, 8 min.	95	1	11	3	1	0	111	86.5
1%, 5 min.	1	1	3	4	6	0	15	13.3
1%, 30 min.	44	2	2	6	0	0	54	85.2
1%, 75 min.	94	1	3	10	2	1	111	85.5
Stratified check	165	2	0	0	0	0	167	100.0

The reasons for the differences between the two locations are not clear. A possible explanation lies in the laboratory finding that thiourea is easily removed from bitterbrush seed by washing with water. The greater precipitation at Flukey Spring may have leached some of the thiourea from the heavier treatments until they held an optimum amount. Since there was not as much precipitation at Doyle, leaching might not have occurred there. Where considerable leaching occurs, it may be necessary to use a heavier thiourea treatment than would otherwise be optimum. Unquestionably, a very light treatment with thiourea gave the poorest seedling emergence at both areas.

None of the thiourea treatments demonstrated any carry-over effect on survival after emergence (table 3). Cutworms killed a large number of seedlings, especially at Doyle, tending to mask treatment effects. However, at Flukey Spring, where cutworms were less troublesome, there were no significant differences in mortality after emergence between the different treatments. The highest seedling mortality was in the stratified check at Doyle.

At Flukey Spring there was considerable additional germination the second spring after planting (table 4). An early weeding at Doyle may have inadvertently destroyed germinating seed. The thiourea treatments which gave the poorest first-year emergence were best the second year, based on percent of seed left after first-year emergence. This means that second-year emergence probably occurred from seed whose dormancy was incompletely broken by thiourea, then later was fully broken by over-wintering. First-year emergence is most desirable to minimize competition from other vegetation. Therefore, second-year or hold-over emergence should not be relied on.

Table 3.--Bitterbrush seedling mortality first growing season

Treatment	Flukey Spring		Doyle Area	
	Number	Percent	Number	Percent
3%, 30 sec.	3	21.4	18	46.1
3%, 2 min.	2	10.5	40	45.4
3%, 3 min.	3	11.1	42	41.6
3%, 4 min.	10	29.4	40	40.8
3%, 8 min.	10	9.0	24	31.2
1%, 5 min.	2	13.3	11	27.5
1%, 30 min.	7	13.0	69	52.3
1%, 75 min.	22	19.8	36	46.6
Stratified check	30	18.0	31	79.5

Table 4.--First and second season seedling emergence from thiourea-treated and stratified bitterbrush seed, Flukey Spring

Treatment	1956 seedling emergence	Seed presumably still in ground after 1956 emergence	1957 emergence	Percent emergence in 1957
	- - - - - - - - - Number - - - - - - - - -			
3%, 30 sec.	14	236	56	23.7
3%, 2 min.	19	231	64	27.7
3%, 3 min.	27	223	51	22.9
3%, 4 min.	34	216	37	17.1
3%, 8 min.	111	139	15	10.8
1%, 5 min.	15	235	50	21.3
1%, 30 min.	54	196	34	17.3
1%, 75 min.	111	139	21	15.1
Stratified check	167	83	0	0.0

SUMMARY

Thiourea treatment is an effective method of breaking the dormancy of bitterbrush seed to permit spring planting. This study tested the effects of thiourea on field germination of seed treated at two concentrations for different periods of soaking. The results varied somewhat between the two study areas. At Flukey Spring the largest number of seedlings emerged during the first season from the heaviest thiourea treatments. At Doyle the best thiourea treatments were somewhat lighter. Flukey Spring had more precipitation than Doyle, and some thiourea may have leached from the heavier treated seed.

Some seedlings emerged the second season after planting at Flukey Spring with some of the weaker thiourea treatments. The two most effective treatments had the lowest second season emergence. Probably, dormancy incompletely broken by the thiourea treatments was later finally broken by cold stratification during the winter.

The thiourea treatments materially affected the rate of seedling emergence during the first season.

There was no evidence that the thiourea treatments had any effect on survival after emergence.